

Claims:

1. Surface profiling apparatus comprising:  
a first optical waveguide including a plurality of sensor sections in which a plurality of optical waveguide grating curvature sensing devices are respectively provided; and  
optical interrogation means operable to interrogate the optical waveguide grating curvature sensing devices, to determine the curvature experienced by each device,  
whereby a profile of a surface to which the sensor sections of the first optical waveguide are coupled may be constructed from the curvatures sensed by the optical waveguide grating curvature sensing devices.
2. Apparatus as claimed in claim 1, wherein the optical waveguide is an optical fibre, such as a silica-glass optical fibre or a polymer optical fibre.
3. Apparatus as claimed in claim 2, wherein the first optical fibre comprises a core, an inner cladding layer surrounding the core, and at least a first outer cladding layer surrounding the inner cladding layer, the refractive index of the inner cladding layer being less than the refractive index of the core, and the refractive index of the first outer cladding layer being less than the refractive index of the inner cladding layer.
4. Apparatus as claimed in claim 3, wherein the first optical fibre further comprises a second outer cladding layer surrounding the first outer cladding layer in order to isolate light propagating within a cladding mode of the inner cladding layer from a medium surrounding the outermost cladding layer, the refractive index of the second outer cladding layer being less than the refractive index of the first outer cladding layer.

5. Apparatus as claimed in claims 3 or 4, wherein the surface profiling apparatus further comprises at least one optical waveguide strain sensor.
6. Apparatus as claimed in claim 5, wherein one or more optical waveguide strain sensors are provided within the first optical waveguide, between a or each pair of optical waveguide grating curvature sensing devices.
7. Apparatus as claimed in claims 5 or 6, wherein one or more optical waveguide strain sensors are provided within a second optical waveguide, such as a second optical fibre, between a or each pair of optical waveguide grating curvature sensing devices, or generally adjacent to, and generally parallel with, a or each optical waveguide grating curvature sensing device.
8. Apparatus as claimed in claims 1 or 2, wherein the first optical fibre comprises an asymmetric optical fibre, having a radially asymmetric core or a radially asymmetric cladding layer, such as D-shaped optical fibre.
9. Apparatus as claimed in claim 8, wherein the surface profiling apparatus further comprises at least one optical waveguide strain sensor provided within a second optical waveguide, in the form of a second optical fibre.
10. Apparatus as claimed in claim 9, wherein a strain sensor is provided between a or each pair of optical waveguide grating curvature sensing devices, and/or a strain sensor is provided generally adjacent to, and generally parallel with, a or each optical waveguide grating curvature sensing device.
11. Apparatus as claimed in any of claims 5 to 10, wherein the or each optical waveguide strain sensor is an optical waveguide grating strain sensor, such as a Bragg grating.
12. Apparatus as claimed in any preceding claim, wherein the optical waveguide grating curvature sensing devices comprise optical waveguide

grating devices, such as a long period grating, two long period gratings arranged to together define an in-line Mach-Zehnder interferometer, a Bragg grating, a chirped Bragg grating, a Bragg grating having a tapered and/or apodised periodic refractive index variation amplitude, or two Bragg gratings arranged to together define a Fabry-Perot etalon.

13. Apparatus as claimed in any of claims 5 to 12, wherein the surface profiling apparatus further comprises coupling means for coupling the sensor sections of the first optical waveguide to the surface to be profiled and additional coupling means for coupling the or each optical waveguide strain sensor to the surface to be profiled, a coupling means comprising a carrier member, and one or more sensor sections of the optical waveguide or one or more optical waveguide strain sensors being fixed to or embedded within a carrier member.

14. Apparatus as claimed in 13, wherein the coupling means comprises a plurality of carrier members mounted on a support structure, one or more optical waveguide sensor sections or one or more optical waveguide strain sensors being fixed to or embedded within each carrier member.

15. Apparatus as claimed in claims 13 or 14, wherein the or each carrier member is deformable and preferably comprises a flexible skin fixed to a partially rigid, expandable skeleton structure.

16. Apparatus as claimed in any of claims 5 to 15, wherein the optical interrogation means is a derivative spectroscopy or synthetic heterodyne based optical interrogation means operable to detect changes in the spectral profile of an optical waveguide grating curvature sensing device, the optical interrogation comprising:

an optical source operable to generate a wavelength modulated optical signal at a wavelength within the spectral range of an optical waveguide grating

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curvature sensing device to be interrogated, the optical source being optically coupled to an one, input, end of the respective optical waveguide; and

optical detection means optically coupled to the other, output, end of the optical waveguide, and being operable to detect changes in the spectral transmission profile of the optical waveguide grating curvature sensing device being interrogated and to thereby determine the curvature experienced by the grating curvature sensing device.

17. Apparatus as claimed in claim 16, wherein the optical interrogation apparatus is further operable to interrogate the or each optical waveguide strain sensor, to determine the strain experienced by each strain sensor.

18. Respiratory function monitoring apparatus comprising surface profiling apparatus according to the first aspect of the invention.

19. Apparatus as claimed in claim 18, wherein the support structure of the coupling means comprises a garment of a size and shape suitable to closely fit across at least part of the thoracoabdominal surface of a subject whose respiratory function is to be monitored.

20. Apparatus as claimed in claims 18 or 19, wherein the optical interrogation means further comprises optical signal processing means operable to generate a 2- or 3-dimensional wire-frame image of the thoracoabdominal surface of a subject wearing the respiratory function monitoring apparatus, and is most preferably operable to repeatedly generate the image in real time, to thereby generate a changing, updating image of the thoracoabdominal surface.

21. Surface profiling apparatus substantially as described above with reference to the accompanying drawings.

22. Respiratory function monitoring apparatus substantially as described above with reference to the accompanying drawings.